SITE-WIDE GROUNDWATER MONITORING PLAN
YERINGTON MINE SITE – REVISION 1

December 15, 2009

PREPARED FOR:

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4 CENTERPOINT DRIVE

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ARC	Atlantic Richfield Company
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
COC	Chain-of-Custody
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
DC	Direct Current
DI	Deionized (water)
DO	Dissolved Oxygen
DQO	Data Quality Objective
DTW	Depth to Water
DWMP	Domestic Well Monitoring Plan
EPA	U.S. Environmental Protection Agency
ESI	Environmental Standards Inc.
FB	Field Blanks
FSP	Field Sampling Plan
GMP	Groundwater Monitoring Plan
GMR	Groundwater Monitoring Report
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
HFA	Hydrogeologic Framework Assessment
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAD	North America Datum
NDEP	Nevada Division of Environmental Protection
NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PEL	Permissible Exposure Level
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
PWS	Pumpback Well System
QAPP	Quality Assurance Project Plan
QA	Quality Assurance
QC	Quality Control
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting Limit
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SC	Specific Conductance
SOP	Standard Operating Procedure
SOW	Scope of Work
TA-I	TestAmerica Irvine, California
TA-R	TestAmerica Richland, Washington
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
UAO	Unilateral Administrative Order
USGS	U.S. Geological Survey
WRA	Work Risk Assessment

%	percent
°C	degrees Centigrade
amsl	above mean sea level
cm	centimeter
ft	foot
g	gram
L	liter
M	Molar
mg	milligram
ml	milliliters
ml/min	milliters per minute
mV	milliVolt
pCi	picoCurie
s.u.	standard units (pH)
µg	microgram
µm	micrometer
µR	microRoentgen
µS	microSiemens

SECTION 1.0
INTRODUCTION

Atlantic Richfield Company (ARC) prepared and submitted a draft version of the Site-Wide Groundwater Monitoring Plan (GMP; Brown and Caldwell and Norwest Applied Hydrology, 2007) on August 8, 2007. The GMP was prepared pursuant to Section 6.0 of the Scope of Work (SOW) which was attached to the Administrative Order (Order) for Remedial Investigation and Feasibility Study (RI/FS) of the Anaconda/Yerington Mine Site (Site). The Order was issued by the U.S. Environmental Protection Agency - Region 9 (EPA) to ARC on January 12, 2007 (EPA, 2007). EPA has not provided comments to the draft GMP but, in a letter to ARC dated November 18, 2008, EPA requested that ARC update the draft GMP to incorporate: 1) monitor wells that were installed as part of the Hydrogeologic Framework Assessment (HFA) programs (Brown and Caldwell, 2006 and 2008a), which support the RI activities associated with the Site-Wide Groundwater Operable Unit (OU-1) and have been monitored quarterly since installation; and 2) revisions to the Site-Wide Quality Assurance Project Plan (QAPP).

In response to EPA's letter dated November 18, 2008, ARC has prepared this revised GMP to document procedures that have been implemented since August 2007 for the Site-wide groundwater monitoring program. The Site is located adjacent to the City of Yerington in western Nevada (Figure 1-1). Figure 1-2 shows the locations of the eight operable units (OUs) that were designated in the SOW to focus investigation and remedial activities at the Site. The eight OUs include:

- Site-Wide Groundwater (OU-1)
- Pit Lake (OU-2)
- Process Areas (OU-3)
- Evaporation Ponds and Sulfide Tailings (OU-4)
- Waste Rock Areas (OU-5)
- Oxide Tailings Areas (OU-6)
- Wabuska Drain (OU-7)
- Arimetco facilities (OU-8; EPA responsibility)

This revised GMP presents a comprehensive Site-wide groundwater plan that also incorporates and continues groundwater monitoring activities established in conjunction with the operation and maintenance (O&M) of the Pumpback Well System (PWS). Groundwater monitoring at the Site began in 1982 in response to a Nevada Department of Environmental Protection (NDEP) order, and the PWS was constructed under the State of Nevada Administrative Order on Consent to Anaconda Minerals Company (ARC's predecessor) dated October 1, 1985. This revised GMP also incorporates relevant elements of the QAPP (Revision 5; Environmental Standards, Inc. [ESI] and Brown and Caldwell, 2009) and the updated Site-Wide Plan (HASP; Brown and Caldwell, 2009a). This GMP addresses routine sampling of groundwater monitor wells. Non-routine groundwater sampling activities (e.g., depth-specific sampling during borehole drilling, non-routine chemical analyses such as isotopic analyses) are addressed, as needed, in OU-specific documents. A draft Domestic Well Monitoring Plan (DWMP; Brown and Caldwell, 2009b) was submitted to EPA for review on December 11, 2009.

The remainder of Section 1.0 of this GMP: 1) describes the evolution of Site monitoring activities and relevant regulatory background (Section 1.1); 2) presents an inventory of wells on and in the vicinity of the Site including active wells that are monitored as part of the GMP, inactive industrial or other wells not used for monitoring, and known abandoned wells (Section 1.2); 3) identifies the specific objectives of this GMP (Section 1.3; 4) summarizes aspects of the conceptual Site hydrogeologic model that are relevant to identifying and selecting wells that comprise the groundwater monitoring network (Section 1.4); and, 5) discusses coordination between GMP activities and other monitoring and relevant characterization activities associated with future investigation and remedial work specific to the individual OUs (Section 1.5).

Section 2.0 of this GMP describes the groundwater monitoring network including the basis for the location and depth of monitor wells, the frequency of sampling and analytical parameters. Section 3.0 describes the quality assurance/quality control (QA/QC) procedures applicable to the GMP. Section 4.0 presents the Field Sampling Plan (FSP) for groundwater monitoring, which contains the procedures and methods for sampling the Site monitor wells.

Reporting requirements and the schedule for submittal of reports and deliverables are discussed in Section 5.0. Procedures for future modifications to the GMP are presented in Section 6.0. Health and safety aspects of the FSP are addressed in Section 7.0. The references cited in this GMP are listed in Section 8.0. Standard Operating Procedures (SOPs) referenced in this GMP are included in Appendix E of the QAPP.

1.1 Historic Groundwater Monitoring and Regulatory Background

Although groundwater characterization and monitoring activities at the Site have been conducted since as early as 1976 (Table 1-1), historic monitoring activities were primarily associated with the PWS. The initial PWS (pumpback wells PW-1 through PW-5) and the adjacent unlined 23-acre pond for the containment and evaporation of extracted shallow groundwater were activated near the north perimeter of the Site in 1986 by ARC pursuant to a 1985 NDEP Unilateral Administrative Order (UAO). Subsequently, the PWS and the associated monitoring program were expanded to include wells that were installed to support investigation activities in the various operable units, especially the Process Areas Operable Unit (OU-3) and the Site-Wide Groundwater Operable Unit (OU-1).

Pumpback system components are described in more detail in the 2008 Pumpback Well System Operation and Maintenance Report Yerington Mine Site (Brown and Caldwell, 2009c), and are shown on Figure 1-3. Table 1-1 provides a chronological summary of pre-1985 groundwater monitoring activities, implementation of the original PWS and associated groundwater monitoring program in 1986, and administrative/technical changes and program modifications implemented from 1987 through 2009. Bold font in Table 1-1 indicates significant improvements or modifications to the groundwater monitoring network. In addition, the names of monitor wells in Table 1-1 that are currently part of the active GMP monitoring program include suffixes that identify the shallow (S), intermediate (I), deep (D), and bedrock (B) hydrostratigraphic zone designations, which are discussed in Section 1.4.

Table 1-1. Chronology of Pumpback Well System and Groundwater Monitoring Activities	
1976 (June)	U.S. Geological Survey (USGS) installed monitor wells USGS-2BS and USGS-13S, and other monitor wells that no longer exist.
1982 - 1984	Groundwater investigation conducted and ten monitor wells installed (D5AC-1S, D8AB-1, W5AA-1, W5AA-2S, W32DC-D, W4CB-1I, W4CB-2I, W5AB-1, W5AB-2S, and W5BB-S) in accordance with 1982 NDEP order.
1985	**Installed East Wellfield**: Wells PW-1S through PW-5S, northeast of unlined evaporation pond; installed monitor wells UW-1S and D4BC-1.
1986 (March)	Implemented pumpback well operations, monitoring, and performance reporting to NDEP; three pumpback wells, PW-2S, PW-3S, and PW-4S operated regularly after startup per NDEP approval. **Implemented Monitoring Program:** Nine monitor wells sampled semi-annually for pH, sulfate, and iron (D4BC-1S, D8AB-1, W5AA-1, W4CB-1I, W5AB-1, USGS-2BS, USGS-13S, UW-1S, and Phipps, aka DW-47). [D8AB-1 unusable after November 1988.]
1986 – 2000	East Wellfield: PW-5S offline until April 1999 and PW-1S offline until June 2000 per NDEP approval.
1989	Three piezometers (B-1, B-2S, and B-3S) installed in vicinity of pumpback wells PW-2S and PW-3S. [B-1 unusable after June 1993.]; Existing monitoring wells D5AD-1, W4CB-1I, and W4CB-2I added to the monthly water level monitoring program.
1991 - 1996	East Wellfield: PW-S, PW-3S, and PW-4S operated six months per year per NDEP approval.
1992 & 1995	Unassociated Arimetco Activities: Installed five monitor wells: MW-1S, MW-2S, MW-3S, and MW-4S in 1992, and monitor well MW-5S in 1995. [MW-3 abandoned by Arimetco]
1992 – 1999	East Wellfield: PW-4S offline until April 1999, per NDEP approval.
1996 - 1997	Existing monitor well W5AC-1 added to the monitoring program in 1996. Monitor well W5AB-1 replaced with new well W5AB-3 September 1997.
1997	Initiated continuous (24/7) operation of all pumpback wells, except when operation and maintenance activities necessitated temporary shutdown of individual wells.
1998	Regional groundwater flow and transport model developed to determine potential migration of affected groundwater from the north boundary of the Site. Subsequent capture zone modeling was used to design an expanded pumpback system. **Installed North Wellfield:** Six pumpback wells, PW-6S through PW-11S, located on berm between the north and middle cells of the asphalt-lined evaporation ponds, per NDEP/Bureau of Land Management (BLM) direction. **Installed/Replaced Wells:** Installed two additional monitor wells: W5AA-3S and W5DB-D near the Evaporation Ponds. Implemented evaporation pond modifications: compacted clay liner and partitioned pond into three cells separated by compacted clay berms.

Table 1-1. Chronology of Pumpback Well System and Groundwater Monitoring Activities - Continued	
1999	Middle evaporation pond cell lined with high-density polyethylene (HDPE) material (over the clay liner) for protection against berm erosion and clay liner desiccation during summer dry season. **Monitoring Program Summary:** Added two existing monitor wells W5BB-S and W32DC-D to monitoring program and resumed operation of pumpback wells PW-4S and PW-5S (April) per NDEP request. Changed from semi-annual monitor well sampling to quarterly sampling; and expanded the water analysis program to include NDEP Profile 1 constituents.
2000	Resumed operation of pumpback well PW-1S (July). EPA installed shallow monitor well USEPA-2S (Luzier Lane at Hwy 95A intersection).
2001	South cell of evaporation pond enlarged, clay liner re-compacted, and clay liner covered with HDPE synthetic liner. Arimetco monitor wells MW-1S, MW-2S, MW-4S, and MW-5S added to the monthly water level monitoring program, per NDEP request. **Monitoring Program Summary:** Water analysis / water level – 11 Pumpback wells and 13 monitor wells. Water level only – 11 monitor wells.
2002 (June)	**Monitoring Program Summary:** Groundwater quality monitoring program expanded in June per NDEP direction: (1) two new monitoring wells, MW2002-1S and MW2002-2S; (2) EPA well USEPA-2S; (3) ten Arimetco monitor wells (MW-1S, MW-2S, MW-4S, MW-5S, WW-1S, WW-2S, WW-10, WW-40B, WW-59B, and Weed Heights supply well WW-36B); and (4) one irrigation well, two Yerington Paiute Tribe community wells, and 18 domestic wells (annual water analysis). Changed water analysis program from NDEP Profile 1 constituents to NDEP Profile 2 constituents without cyanide per NDEP direction.
2003	Changed East Wellfield wellhead configuration from vaults (confined space) to an on-grade configuration (PW-1S through PW-5S). Well PW-5S wellhead piping modified to enable direct discharge to middle or north evaporation pond cells to reduce potential mineral encrustation of main header pipe. 20 double cleanouts added to header pipe between PW-3S and PW-7S, and inside of header pipe mechanically scraped and flushed to clear encrusting mineral deposits. Effective September 19, 2003: Groundwater sampling and analysis conducted in accordance with the Yerington Mine Site QAPP.

Table 1-1. Chronology of Pumpback Well System and Groundwater Monitoring Activities - Continued	
2005	Installed three additional monitoring program wells in Process Area, PA-MW-1S, PA-MW-2S, and PA-MW-3S (January). Header Pipe Modification (March): Installed additional 1,100 feet of 3-inch ABS header pipe on west side of evaporation ponds to provide flexibility in management of water distribution to evaporation ponds and enable performance of header pipe preventive maintenance on either one of the wellfields without shutting down both wellfields. Modified well PW-4 wellhead piping to enable direct discharge to middle evaporation pond cell to reduce potential mineral encrustation of main header pipe. Effective March 31, 2005: Continued operations and monitoring program activities under the UAO for Initial Response Activities, EPA Docket No. 9-2005-0011. Pumpback Well System Interim Operations, Maintenance, and Monitoring Plan revised in accordance with the 2005 UAO. **Monitoring Program Summary:** Total of 46 Site Wells - 11 pumpback wells and 35 monitor wells; Quarterly Site-Wide Sampling Events – 11 pumpback wells and 29 monitor wells. Monthly Site-Wide Water Level Monitoring – 11 pumpback wells and 31 monitor wells. Annual Off-Site Water Sampling Event – 23 off-Site water supply wells (20 domestic wells, 2 community wells, and 1 irrigation well). Implementation of the First-Step HFA (Brown and Caldwell, 2006) under the UAO issued by EPA for Initial Response Activities, EPA Docket No. 9-2005-0011. Resulted in the installation of the first phase of B/W wells and three monitor wells in the Process Areas.
2006	Effective January 1, 2006: Laboratory analysis performed by Del Mar Analytical, Energy Laboratories and/or Severn Trent Laboratories; laboratory data validation performed by Environmental Standards, Inc. Fifteen Hydrogeologic Framework Assessment wells added to the monitoring program. Effective October 2006: Groundwater sampling and analysis conducted in accordance with the Yerington Mine Site QAPP, Revision 1. **Monitoring Program Summary:** Total of 61 Site Wells - 11 pumpback wells and 50 monitor wells; Quarterly Site-Wide Sampling Events – 11 pumpback wells and 44 monitor wells. Monthly Site-Wide Water Level Monitoring – 11 pumpback wells and 31 monitor wells. Annual Off-Site Water Sampling Event – 22 off-Site water supply wells (19 domestic wells, 2 community wells, and 1 irrigation well); domestic well DW-42 removed from program at landowner's request
August 8, 2007	Draft Site-Wide Groundwater Monitoring Plan (Brown and Caldwell and Norwest Applied Hydrology, 2007) submitted pursuant to Section 6.0 of the SOW attached to the Administrative Order for Remedial Investigation and Feasibility Study, U.S. EPA Docket No. 9-2007-0005.
2007 - 2008	Implementation of the Second-Step HFA (Brown and Caldwell, 2007) including the installation of the second phase of B/W wells, and the preparation of several OU-specific work plans that describe additional on-Site monitor well installations under the Administrative Order for Remedial Investigation and Feasibility Study, U.S. EPA Docket No. 9-2007-0005. Monitor well identification numbers modified to include a suffix designating the hydrostratigraphic zone in which the well screen is positioned, including the shallow (S), intermediate (I), and deep (D) alluvial aquifer hydrostratigraphic zones and the bedrock (B) hydrostratigraphic zone.

Table 1-1. Chronology of Pumpback Well System and Groundwater Monitoring Activities - Continued	
2008	Implementation of the Anaconda Evaporation Ponds Removal Action Characterization Work Plan (Brown and Caldwell, 2008b), and the initial phase of the Evaporation Ponds/Sulfide Tailings Operable Unit 4 (OU-4) RI/FS prescribed under the Administrative Order for Remedial Investigation and Feasibility Study, U.S. EPA Docket No. 9-2007-0005.
November 17, 2008	EPA approves the elimination of well MW-1S from the monitoring network in response to a request from ARC in a letter to the EPA dated October 16, 2008.
February 2009	Installation of nine LEP-MW series groundwater monitoring wells north of the Pumpback Well System per EPA approval.
March 25, 2009	Temporary shutdown of the groundwater extraction wells comprising the Pumpback Well System (PW-1S through PW-11S) and continued sampling of the wells for routine groundwater monitoring purposes. PWS shutdown for one year was approved by the EPA on February 13, 2009.
June 2009	Groundwater sampling and analysis conducted in accordance with the Yerington Mine Site QAPP, Revision 5 dated May 20, 2009.
November 2009	EPA requires ARC to implement a separate Domestic Well Monitoring Plan (DWMP) beginning in March 2010.

1.2 Well Inventory

As indicated in Table 1-1, the groundwater monitoring network has evolved over time due to the expansion of the PWS, the addition of monitor wells associated with Site investigations, and the elimination of wells for various reasons. An inventory of known wells located within the Site-wide groundwater study area is provided in Tables 1-2 through 1-4. The inventory is based on: 1) review of historic Site maps and reports; 2) the State of Nevada Division of Water Resources Well Log Database; and 3) an on-Site well inspection and search conducted on July 10, 2007.

The inventory includes: 1) active wells included in the groundwater monitoring program, which are listed in Table 1-2; 2) inactive wells used for historic industrial/mining activities (e.g., wells used for pit dewatering and mine water supply) but not included in the monitoring program, which are listed in Table 1-3; and 3) wells that have been properly abandoned pursuant to State of Nevada regulations, destroyed due to agricultural development, mine facility expansion, building construction, or some other activity and the method of abandonment is unknown or undocumented, or could not be located in July 2007 to document well status. The locations of the wells in Tables 1-2 through 1-4 are shown on Figure 1-4.

Table 1-2. Inventory of Active Groundwater Monitor Wells

Revised Well Name	Former Well Name	Original Proposed Use	Original User
Pumpback System Wells			
PW-1S	PW-1	Remediation well	Anaconda
PW-2S	PW-2	Remediation well	Anaconda
PW-3S	PW-3	Remediation well	Anaconda
PW-4S	PW-4	Remediation well	Anaconda
PW-5S	PW-5	Remediation well	Anaconda
PW-6S	PW-6	Remediation well	Atlantic Richfield
PW-7S	PW-7	Remediation well	Atlantic Richfield
PW-8S	PW-8	Remediation well	Atlantic Richfield
PW-9S	PW-9	Remediation well	Atlantic Richfield
PW-10S	PW-10	Remediation well	Atlantic Richfield
PW-11S	PW-11	Remediation well	Atlantic Richfield
Shallow Zone Monitor Wells			
B-2S	B-2	Piezometer	Anaconda
B-3S	B-3	Piezometer	Anaconda
B/W-1S	B/W-1S	Monitoring well	Atlantic Richfield
B/W-3S	B/W-3S	Monitoring well	Atlantic Richfield
B/W-4S	B/W-4S	Monitoring well	Atlantic Richfield
B/W-5SR	B/W-5RS	Monitoring well	Atlantic Richfield
B/W-6S	B/W-6S	Monitoring well	Atlantic Richfield
B/W-8S	B/W-8S	Monitoring well	Atlantic Richfield
B/W-9S	B/W-9S	Monitoring well	Atlantic Richfield
B/W-10S	B/W-10S	Monitoring well	Atlantic Richfield
B/W-11S	B/W-11S	Monitoring well	Atlantic Richfield
B/W-13S	B/W-13	Monitoring well	Atlantic Richfield
B/W-14S	B/W-14	Monitoring well	Atlantic Richfield
B/W-15S	B/W-15	Monitoring well	Atlantic Richfield
B/W-16S	B/W-16	Monitoring well	Atlantic Richfield
B/W-18S	B/W-18S	Monitoring well	Atlantic Richfield
B/W-19S	B/W-19S	Monitoring well	Atlantic Richfield
B/W-20S	B/W-20	Monitoring well	Atlantic Richfield
B/W-21S	B/W-21	Monitoring well	Atlantic Richfield
B/W-22S	B/W-22	Monitoring well	Atlantic Richfield
B/W-25S	B/W-25S	Monitoring well	Atlantic Richfield
B/W-27S	B/W-27S	Monitoring well	Atlantic Richfield
B/W-28S	B/W-28S	Monitoring well	Atlantic Richfield
B/W-29S	B/W-29S	Monitoring well	Atlantic Richfield
D4BC-1S	D4BC-1	Monitoring well	Anaconda
D5AC-1S	D5AC-1	Monitoring well	Anaconda
LEP-MW-1S	LEP-MW-1S	Monitoring well	Atlantic Richfield
LEP-MW-2S	LEP-MW-2S	Monitoring well	Atlantic Richfield

Table 1-2. Inventory of Active Groundwater Monitor Wells

Revised Well Name	Former Well Name	Original Proposed Use	Original User
Shallow Zone Monitor Wells – Continued			
LEP-MW-3S	LEP-MW-3S	Monitoring well	Atlantic Richfield
LEP-MW-5S	LEP-MW-5S	Monitoring well	Atlantic Richfield
LEP-MW-6S	LEP-MW-6S	Monitoring well	Atlantic Richfield
LEP-MW-7S	LEP-MW-7S	Monitoring well	Atlantic Richfield
MW-2S	MW-2	Monitoring well	Arimetco
MW-4S	MW-4	Monitoring well	Arimetco
MW-5S	MW-5	Monitoring well	Arimetco
MW2002-1S	MW2002-1	Monitoring well	Atlantic Richfield
MW2002-2S	MW2002-2	Monitoring well	Atlantic Richfield
P-1S	P-1	Piezometer	Atlantic Richfield
PA-MW-1S	PA-MW-1	Monitoring well	Atlantic Richfield
PA-MW-2S	PA-MW-2	Monitoring well	Atlantic Richfield
PA-MW-3S	PA-MW-3	Monitoring well	Atlantic Richfield
USEPA2S	USEPA2	Monitoring well	U.S. EPA
USGS-13S	USGS-13	Monitoring well	USGS
USGS-2BS	USGS-2B	Monitoring well	USGS
UW-1S	UW-1	Monitoring well	Anaconda
W5AA-2S	W5AA-2	Piezometer	Anaconda
W5AA-3S	W5AA-3	Monitoring well	Atlantic Richfield
W5AB-2S	W5AB-2	Monitoring well	Anaconda
W5AD-1S	W5AD-1	Piezometer	Anaconda
W5BB-S	W5BB	Monitoring well	Anaconda
WRP-1S	WRP-1	Piezometer	Atlantic Richfield
WRP-2S	WRP-2	Piezometer	Atlantic Richfield
WW-1S	WW-1	Industrial well	Anaconda
WW-2S	WW-2	Industrial well	Anaconda
Lyon County Shallow Zone Monitor Wells			
LC-MW-1S	MW-1	Monitoring Well	Lyon County
LC-MW-2S	MW-2	Monitoring Well	Lyon County
LC-MW-3S	MW-3	Monitoring Well	Lyon County
LC-MW-5S	MW-5	Monitoring Well	Lyon County
Intermediate Zone Monitor Wells			
B/W-2I	B/W-2I	Monitoring well	Atlantic Richfield
B/W-3I	B/W-3I	Monitoring well	Atlantic Richfield
B/W-4I	B/W-4I	Monitoring well	Atlantic Richfield
B/W-5IR	B/W-5RI	Monitoring well	Atlantic Richfield
B/W-6I	B/W-6D	Monitoring well	Atlantic Richfield
B/W-7I	B/W-7	Monitoring well	Atlantic Richfield
B/W-8I	B/W-8D	Monitoring well	Atlantic Richfield
B/W-9I	B/W-9I	Monitoring well	Atlantic Richfield
B/W-19I	B/W-19I	Monitoring well	Atlantic Richfield
B/W-25I	B/W-25I	Monitoring well	Atlantic Richfield

Table 1-2. Inventory of Active Groundwater Monitor Wells

Revised Well Name	Former Well Name	Original Proposed Use	Original User
Intermediate Zone Monitor Wells – Continued			
B/W-28I	B/W-28I	Monitoring well	Atlantic Richfield
B/W-29I	B/W-29I1	Monitoring well	Atlantic Richfield
LEP-MW-4I	LEP-MW-4I2	Monitoring well	Atlantic Richfield
LEP-MW-8I	LEP-MW-8I2	Monitoring well	Atlantic Richfield
LEP-MW-9I	LEP-MW-9I2	Monitoring well	Atlantic Richfield
MW2002-2I	MW2002-2I	Monitoring well	Atlantic Richfield
W4CB-1I	W4CB-1	Monitoring well	Anaconda
W4CB-2I	W4CB-2	Monitoring well	Anaconda
W5AA-1I	W5AA-1	Monitoring well	Anaconda
W5AB-3I	W5AB-3	Monitoring well	Atlantic Richfield
Deep Zone Monitor Wells			
B/W-1D1	B/W-1I1	Monitoring well	Atlantic Richfield
B/W-1D2	B/W-1I2	Monitoring well	Atlantic Richfield
B/W-1D3	B/W-1D	Monitoring well	Atlantic Richfield
B/W-2D	B/W-2D	Monitoring well	Atlantic Richfield
B/W-3D	B/W-3D	Monitoring well	Atlantic Richfield
B/W-4D	B/W-4D	Monitoring well	Atlantic Richfield
B/W-5DR	B/W-5RD	Monitoring well	Atlantic Richfield
B/W-9D	B/W-9D	Monitoring well	Atlantic Richfield
B/W-10D	B/W-10D	Monitoring well	Atlantic Richfield
B/W-11D	B/W-11D	Monitoring well	Atlantic Richfield
B/W-18D1	B/W-18I	Monitoring well	Atlantic Richfield
B/W-18D2	B/W-18D	Monitoring well	Atlantic Richfield
B/W-19D	B/W-19D	Monitoring well	Atlantic Richfield
B/W-25D	B/W-25D	Monitoring well	Atlantic Richfield
B/W-27D	B/W-27D	Monitoring well	Atlantic Richfield
B/W-28D	B/W-28D	Monitoring well	Atlantic Richfield
B/W-29D1	B/W-29I2	Monitoring well	Atlantic Richfield
B/W-29D3	B/W-29D	Monitoring well	Atlantic Richfield
W32DC-D	W32DC	Monitoring well	Anaconda
W5DB-D	W5DB	Monitoring well	Anaconda
Bedrock Monitor Wells			
B/W-11B	B/W-11D3	Monitoring well	Atlantic Richfield
B/W-23B	B/W-23	Monitoring well	Atlantic Richfield
WW-36B	WW-36	Industrial well	Anaconda
WW-40B	WW-40	Industrial well	Anaconda
WW-59B	WW-59	Industrial well	Anaconda

Table 1-3. Inventory of Inactive Industrial Wells

Well Name	Other Name	Water Source	Original User	Current Use	Field Search Results
Well 12C	MW-12C	Alluvium	Anaconda	None; no power	Pump in well
Well 1-A	PWell 1	No record found	Anaconda	None; no power	Welded cap
Well 2-B	None	No record found	Anaconda	None; no power	Pump in well
Well 3	PWell 3	Bedrock	Anaconda	None; no power	Site inaccessible
Well 5	PWell 5	No record found	Anaconda	None; no power	Damaged casing
Well 7	PWell 7	No record found	Anaconda	None; no power	Damaged casing
Well 8	WW-08	No record found	Anaconda	None; no power	Open to 200+ feet
WW-1	W-1	No record found	Anaconda	Monitoring well	Casing bent
WW-10	None	Alluvium/ Bedrock	Anaconda	None; no power	Pump needs repair
WW-2	W-2	No record found	Anaconda	Monitoring well	Good
WW-23	None	No record found	Anaconda	None	Open to 200+ feet
WW-3	None	No record found	Anaconda	None	Damaged casing
WW-4	None	No record found	Anaconda	None	Open to 200+ feet
WW-40	Pit Edge	No record found	Anaconda	Monitoring well	Pump in well
WW-56	None	No record found	Anaconda	Supply well	Pump in well

Table 1-4. Inventory of Abandoned Wells

Well Name	Other Name	Water Source	Original User	Original Use	Field Search Results
B-1	None	Alluvium	Anaconda	Monitoring	No surface evidence of wellhead found on July 10, 2007
D8AB-1	None	Alluvium	Anaconda	Monitoring	No surface evidence of wellhead found on July 10, 2007
MW-3	MW-03	Alluvium	Arimetco	Monitoring	No surface evidence of wellhead found on July 10, 2007
1A	USGS-1A	Alluvium	USGS	Test well	Casing found inaccessible on July 10, 2007
1B	USGS-1B	Alluvium	USGS	Test well	Surface casing found plugged with soil on July 10, 2007
3	USGS-3	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
4A	USGS-4A	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
4B	USGS-4B	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
5A	USGS-5A	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
5B	USGS-5B	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
6	USGS-6	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
7	USGS-7	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
8	USGS-8	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
9	USGS-9	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
10	USGS-10	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
11	USGS-11	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
12	USGS-12	Alluvium	USGS	Test well	No surface evidence of wellhead found on July 10, 2007
I	None	Alluvium	No record found	Irrigation	No surface evidence of wellhead found on July 10, 2007
S	None	Alluvium	No record found	Domestic	No surface evidence of wellhead found on July 10, 2007

Table 1-4. Inventory of Abandoned Wells					
Well Name	**Other Name**	**Water Source**	**Original User**	**Original Use**	**Field Search Results**
Well 1	None	Bedrock	Anaconda	Industrial	No surface evidence of wellhead found on July 10, 2007
Well 2	PWell 2	Bedrock	Anaconda	Industrial	No surface evidence of wellhead found on July 10, 2007
Well 4	None	Alluvium	Anaconda	Industrial	No surface evidence of wellhead found on July 10, 2007
Well 22	MW-22	Alluvium	Anaconda	Industrial	No surface evidence of wellhead found on July 10, 2007
Well 26	MW-26	Alluvium	Anaconda	Industrial	Surface casing found plugged with soil on July 10, 2007
Well 29	MW-29	Alluvium	Anaconda	Industrial	No surface evidence of wellhead found on July 10, 2007
Well 35	MW-35	Alluvium	Anaconda	Industrial	Surface casing found plugged with soil on July 10, 2007

1.3 Monitoring Objectives

The primary objective of the GMP program is to collect information to support technical decisions that will be made by the EPA Remedial Project Manager (RPM) and the project team for the Site-Wide Groundwater OU and other OUs where groundwater is a concern. Specific monitoring objectives include, but are not limited to, the following:

- Periodically monitoring groundwater flow conditions;
- Characterizing and monitoring the nature and extent of potential Site-related groundwater constituents;
- Monitoring temporal trends in the magnitude and distribution of potential groundwater constituents;
- Monitoring potential off-Site migration of constituents via groundwater;
- Assessing what, if any, potential risk is posed to human health and the environment by mine-related groundwater;
- Evaluating the optimal frequency of monitoring, appropriate number of analytes, and optimal well network configuration; and
- Assessing the performance of the PWS.

Related groundwater monitoring objectives that are, or will be, addressed more directly via remedial investigations specific to the OUs and/or future remedial activities include: 1) identification of potential sources of chemical constituents; 2) differentiation of background and mine-related groundwater; and 3) evaluation of remedy performance.

1.4 Hydrogeologic Conceptual Site Model Overview

This brief overview of select hydrogeologic conceptual site model (HCSM) elements emphasizes the hydrostratigraphic zones in the alluvial aquifer, which directly relate to the design of the groundwater monitoring well network. A more comprehensive discussion of the HCSM is presented in the *Conceptual Site Model for the Yerington Mine Site* (Revision 3; Brown and Caldwell and Integral Consulting Inc., 2009) and the *Second Step Hydrogeologic Framework Assessment Data Summary Report* (Brown and Caldwell, 2008a). The HCSM will continue to be refined as additional data are collected during quarterly groundwater monitoring activities, and field investigations associated with the Site-wide Groundwater OU and other Site OUs.

The Site is located on the west side of the Mason Valley, a fault-bounded, down-dropped structural basin surrounded by mountains to the east and west. The Singatse Range borders the west side of Mason Valley and defines a 'no-flow' boundary for groundwater in the alluvial aquifer. The Walker River is the primary source of natural recharge to the alluvial aquifer and flows in a northerly direction less than one mile east of the Site. Geologic formations underlying the northern portion of the Site consist of unconsolidated alluvial, fluvial, and lacustrine sediments of variable thickness overlying Tertiary volcanic and Jurassic intrusive bedrock.

Alluvial deposits consist of clastic sediments ranging in size from clay to cobbles. Based on logs from soil borings, monitor wells, and test pits, the shallow sediments consist of silty clay and clayey sand with interbedded lenses of sand and gravel. Figure 1-5 presents a north-south hydrogeologic cross section through the Site, which extends from the southernmost (B/W-13) to the northernmost (B/W-10) groundwater monitor wells. This generalized cross section (10x vertical exaggeration) depicts the relationship between the bedrock and alluvial groundwater flow systems, groundwater elevations (measured in October 2009) and the surface of the Yerington Pit Lake (August 2009). Alluvial hydrostratigraphic zones at the Site have been designated based on the occurrence of discontinuous clay or fine grained silt layers (i.e., Upper and Lower Clays) that were initially identified by Seitz et al. (1982), and subsequently encountered during the drilling and installation of monitor wells (Brown and Caldwell, 2006; Brown and Caldwell, 2007). The hydrostratigraphic zones are defined by elevation as follows:

- Shallow: > 4,300 feet amsl
- Intermediate: 4,420 to 4,300 feet amsl
- Deep: < 4,240 feet amsl

Criteria used to assign a hydrostratigraphic designation are based on the position of the well screen relative to the: Upper and Lower Clays, if present, and, more commonly, the elevations listed above. A hydrostratigraphic zone designation of 'bedrock' has been assigned to wells with screen intervals in bedrock, regardless of elevation. Monitor well screen intervals and hydrostratigraphic zone designations for the active wells that comprise the Site-wide groundwater monitoring network are presented in Figure 1-6.

Regionally, alluvial groundwater in the Mason Valley and near the Site generally flows to the north (Nork, 1989). In the vicinity of the Site, the alluvial groundwater flow regime is affected locally by: 1) the Yerington Pit, which currently functions as a localized hydraulic sink for alluvial and bedrock groundwater; 2) bedrock in the Singatse Range to the west of the Site, which functions as a no-flow boundary to alluvial groundwater; 3) bedrock outcrops on the eastern margin of the Site (the Singatse Spur), which may impede groundwater flow from the West Campbell Ditch and the Walker River to the alluvium beneath the northern portion of the Site; 4) groundwater pumping and agricultural irrigation using extracted groundwater and surface water on fields located immediately north of the Site; and 5) groundwater extraction associated with the PWS located on the northern margin of the Site. The example potentiometric map shown in Figure 1-7 has been developed using September 2009 groundwater elevations.

1.5 Coordination with Ongoing Monitoring and Future Operable Unit Investigations

Efforts conducted as part of this GMP will be supported and coordinated with ongoing monitoring activities associated with the PWS and future OU investigations. New wells installed as part of ongoing or future remedial investigations specific to the OUs will be incorporated into the monitor well network. Procedures for modifying the GMP are discussed in Section 6.0.

SECTION 2.0
GROUNDWATER MONITORING PLAN

2.1 Monitor Well Locations and Hydrostratigraphic Zone Designations

An effective groundwater monitoring network for the Site must account for potential sources within the various OUs and the complex groundwater flow conditions described in Section 1.4. In addition to an areal distribution of wells relative to known or suspected sources, the monitor well configuration must account for the interpreted direction of groundwater flow and potential solute migration pathways in the three hydrostratigraphic zones described above. Figure 1-6 shows the hydrostratigraphic zone designations for Site monitor wells. Given available domestic well construction information, the intermediate zone generally corresponds to the larger screen intervals for domestic wells described in the draft DWMP (Brown and Caldwell, 2009b). Criteria for monitor wells to be retained within the monitoring network are based on their ability to provide usable, reliable and representative groundwater data, as follows:

- Documentation (including location and vertical control) of borehole lithology to identify hydrostratigraphic zones to be targeted for monitoring;
- Documented well design and construction details (including location and vertical control) to identify the hydrostratigraphic zone that is being monitored at each location;
- Drilling and well construction materials and methods that that might adversely affect chemical concentrations;
- Consistent well screen lengths (generally less than or equal to 20 feet) coincident with water-yielding alluvial horizons or bedrock fractures;
- Integrity of the well casing or other construction elements to maintain sample quality.

Considerations for retaining wells that do not meet the general and specific criteria described above include: 1) long monitoring period; and 2) locations that are important for achieving GMP or other monitoring objectives without a nearby suitable well. Examples of wells with long monitoring period this situation include: 1) domestic well (DW-47 or the ‘Phipps’ well); and 2) older wells associated with monitoring of the PWS (e.g., D4BC-1S, USGS-2BS, UW-1S, B-2S, B-3S, WW-40B, and W5AD-1S), which lack well construction and/or lithologic information.

Wells currently included in the monitoring network are listed in Appendix A, along with well construction and location details, and shown on Plate 1. The wells listed in Appendix A are grouped/sequenced by shallow, intermediate and deep alluvial hydrostratigraphic zones, and bedrock wells. Shallow, intermediate and deep/bedrock monitor wells are shown in Figures 2-1, 2-2 and 2-3, respectively. Well installation diagrams and generalized lithologic logs for the active wells comprising the GMP network are presented in Appendix B.

During the second quarter (2Q) of 2009, the City of Yerington granted ARC access to four groundwater monitor wells located north and east of the Penrose Waste Water Treatment impoundment. As shown on Plate 1, this impoundment is located adjacent to West Campbell Ditch and north of the Peri agricultural fields. The wells were reportedly installed in January 2006 and are referred to in this GMP as LC-MW-1S, LC-MW-2S, LC-MW-3S, and LC-MW-5S. Boring/well construction logs are included in Appendix B. Visual inspection of these wells during the 2Q 2009 monitoring event indicated discrepancies between observed construction and the well logs. The wells were then surveyed to confirm accurate water level measurements and that the wells monitor the shallow hydrostratigraphic zone. The four Lyon County wells are not formally included in the monitoring network, but are temporarily being monitored on a quarterly basis pursuant to this GMP. ARC will evaluate the data and make a recommendation in a future report regarding the need to conduct further monitoring of any of these wells.

2.2 Monitoring Frequency

The frequencies for monitoring water levels and collecting groundwater samples for chemical analyses in the wells comprising the GMP well network are summarized below in Table 2-1. The frequency for obtaining manual water level measurements and water quality samples in each individual well comprising the monitoring network is provided in Appendix C.

Table 2-1. Summary of Monitoring Data Types and Collection Frequencies

Data Type	Locations	Frequency
Water Level Elevation (Manual Measurements)	110 wells total (Plate 1) 65 shallow zone wells, including 11 PWS wells (Figure 2-1) 20 intermediate zone wells (Figure 2-2) 20 deep zone wells and 5 bedrock wells (Figure 2-3).	Monthly
Water Level Elevation (In-Well Electronic Measurements)	23 shallow zone wells (Figure 2-4, Table 2-2) 12 intermediate zone wells (Figure 2-4, Table 2-2) 9 deep zone and 1 bedrock well (Figure 2-4, Table 2-2)	At 30 or 60 minute intervals
Specific Conductance (In-Well Electronic Measurements)	Monitor wells B/W-9S, LEP-MW-8I, LEP-MW-9I, and B/W-1D1 (Figure 2-5, Table 2-2)	Every 30 minutes
Groundwater Quality	103 wells total (Plate 1) 58 shallow zone wells, including 11 PWS wells (Figure 2-1) 20 intermediate zone wells (Figure 2-2) 20 deep zone and 5 bedrock wells (Figure 2-3)	Quarterly

To address variations in groundwater levels in the various hydrostratigraphic zones, water levels in the monitor wells are measured manually on a monthly basis following procedures indicated in SOP-16 of the QAPP - Revision 5. Water levels also are measured in wells associated with the PWS to evaluate system performance.

As specified in the Second-Step HFA, groundwater elevations have been measured daily in 30 or 60 minute increments beginning in mid-2007 at key monitor well locations using dedicated pressure transducers/data loggers. This instrumentation was permanently installed in the wells following procedures detailed in SOP-21 of the QAPP - Revision 5. Wells instrumented with pressure transducers/data loggers are listed in Table 2-2 and shown on Figure 2-4. The purpose of the higher frequency measurements is to better evaluate potential temporal variability in groundwater flow patterns, flow directions, and (horizontal and vertical) hydraulic gradients north of the Site due to agricultural groundwater pumping and irrigation practices. One of the irrigation wells (Well WDW019) is screened across all three hydrostratigraphic zones, based on a total depth of 365 feet bgs and a screen length of 350 feet (see well log in Appendix B). The frequency of groundwater elevation measurements may be modified in the future as the nature of transient groundwater conditions is more fully understood.

Table 2-2. Wells Instrumented for Electronic Water Level and Specific Conductivity Measurements

Well Designation	Measurement Frequency	Hydrostratigraphic Unit
B-3S	Water levels (every 30 minutes)	Shallow
B/W-1S	Water levels (every 30 minutes)	Shallow
B/W-3S	Water levels (every 30 minutes)	Shallow
B/W-4S	Water levels (every 30 minutes)	Shallow
B/W-8S	Water levels (every 30 minutes)	Shallow
B/W-9S	Water levels (every 30 minutes)/ Specific conductivity (every 30 minutes)	Shallow
B/W-10S	Water levels (every 30 minutes)	Shallow
B/W-11S	Water levels (every 60 minutes)	Shallow
B/W-18S	Water levels (every 30 minutes)	Shallow
B/W-25S	Water levels (every 30 minutes)	Shallow
B/W-27S	Water levels (every 30 minutes)	Shallow
B/W-28S	Water levels (every 30 minutes)	Shallow
B/W-29S	Water levels (every 60 minutes)	Shallow
MW2002-1S	Water levels (every 30 minutes)	Shallow
MW2002-2S	Water levels (every 30 minutes)	Shallow
P-1S	Water levels (every 30 minutes)	Shallow
USGS-13S	Water levels (every 30 minutes)	Shallow
WRP-1S	Water levels (every 30 minutes)	Shallow
WRP-2S	Water levels (every 30 minutes)	Shallow
W5AA-2S	Water levels (every 30 minutes)	Shallow
W5AA-3S	Water levels (every 60 minutes)	Shallow
W5AB-2S	Water levels (every 30 minutes)	Shallow
W5BB-S	Water levels (every 30 minutes)	Shallow
B/W-2I	Water levels (every 30 minutes)	Intermediate
B/W-3I	Water levels (every 30 minutes)	Intermediate
B/W-4I	Water levels (every 30 minutes)	Intermediate
B/W-8I	Water levels (every 30 minutes)	Intermediate
B/W-9I	Water levels (every 30 minutes)	Intermediate
B/W-25I	Water levels (every 30 minutes)	Intermediate
B/W-28I	Water levels (every 30 minutes)	Intermediate
B/W-29I	Water levels (every 30 minutes)	Intermediate
LEP-MW-4I	Water levels (every 30 minutes)	Intermediate
LEP-MW-8I	Water levels (every 30 minutes)/ Specific conductivity (every 30 minutes)	Intermediate
LEP-MW-9I	Water levels (every 30 minutes)/ Specific conductivity (every 30 minutes)	Intermediate
W5AA-1I	Water levels (every 60 minutes)	Intermediate
B/W-1D1	Water levels (every 30 minutes)/ Specific conductivity (every 30 minutes)	Deep
B/W-1D3	Water levels (every 30 minutes)	Deep
B/W-2D	Water levels (every 30 minutes)	Deep
B/W-3D	Water levels (every 30 minutes)	Deep
B/W-4D	Water levels (every 30 minutes)	Deep
B/W-9D	Water levels (every 30 minutes)	Deep
B/W-11D	Water levels (every 60 minutes)	Deep
B/W-25D	Water levels (every 30 minutes)	Deep
B/W-27D	Water levels (every 30 minutes)	Deep
B/W-11B	Water levels (every 60 minutes)	Bedrock

Four monitor wells were instrumented to obtain measurements of specific conductivity at 30-minute increments to help evaluate potential temporal variability in groundwater quality due to groundwater pumping at WDW019 and related agricultural irrigation practices. Three monitor wells B/W-9S, LEP-MW-8I, and B/W-1D1 were instrumented pursuant to the *Pumpback Well System Characterization Work Plan* (Brown and Caldwell, 2008c). ARC subsequently elected to instrument LEP-MW-9I for specific conductivity measurements. The locations of the wells instrumented for electronic measurement and logging of specific conductivity are shown on Figure 2-5. Although these data collection activities are not directly related to the Site-Wide GMP, in accordance with the SOW, the daily water level data are included in the Annual Site-Wide Groundwater Monitoring Report (GMR), as discussed in Section 5.4.

2.3 Analytical Parameters

Groundwater samples are collected from monitor wells comprising the GMP monitoring network on a quarterly basis (four events per calendar year) following procedures indicated in SOP-09 of the QAPP. The samples are analyzed for the constituents listed in Table 2-3 pursuant to the data requirements presented in Revision 5 of the QAPP. After four consecutive quarters of monitoring for the parameters listed in Table 2-3, the data are evaluated using the criteria described in Section 6.3 to determine what changes to the analytical parameter list may be warranted. Also, any newly-installed monitor well will be analyzed quarterly for one year for the constituents listed in Table 2-3, unless a different parameter list and/or monitoring frequency has been approved by the EPA.

Table 2-3. Analyte List for Active Monitor Well Sampling

Parameter or Analyte	Total or Dissolved (1)	Method (2)	Reporting Limit (2)	Units
Physical Parameters and Major Anions/Cations				
Alkalinity, Bicarbonate (as $CaCO_3$)	Total	SM 2320B	2.0	mg/L
Alkalinity, Carbonate (as $CaCO_3$)	Total	SM 2320B	2.0	mg/L
Alkalinity, Total (as $CaCO_3$)	Total	SM 2320B	2.0	mg/L
Chloride	Total	EPA 300.0	0.5	mg/L
Fluoride	Total	EPA 300.0	0.5	mg/L
Nitrate (as N)	Total	EPA 300.0	0.1	mg/L
Nitrate (NO_3 + NO_2 as N)	Total	EPA 300.0	0.1	mg/L
Nitrite (as N)	Total	EPA 300.0	0.1	mg/L
pH (Lab)	Total	SM 4500B	0.1	pH units
Phosphorus, Total	Total	EPA 200.7	0.04	mg/L
Sulfate	Total	EPA 300.0	0.5	mg/L
Total Dissolved Solids (TDS)	Total	SM 2540C	10	mg/L
Total Organic Carbon (TOC)	Total	SM 5310B	1.0	mg/L
Metals				
Aluminum	Dissolved	EPA 200.7	0.05	mg/L
Antimony	Dissolved	EPA 200.8	0.002	mg/L
Arsenic	Dissolved	EPA 200.8	0.001	mg/L
Barium	Dissolved	EPA 200.8	0.001	mg/L
Beryllium	Dissolved	EPA 200.8	0.0005	mg/L
Boron	Dissolved	EPA 200.7	0.05	mg/L
Cadmium	Dissolved	EPA 200.8	0.001	mg/L
Calcium	Dissolved	EPA 200.7	0.1	mg/L
Chromium	Dissolved	EPA 200.8	0.002	mg/L
Cobalt	Dissolved	EPA 200.8	0.001	mg/L
Copper	Dissolved	EPA 200.8	0.001	mg/L
Iron	Dissolved	EPA 200.7	0.04	mg/L
Lead	Dissolved	EPA 200.8	0.001	mg/L
Lithium	Dissolved	EPA 200.7	0.002	mg/L
Magnesium	Dissolved	EPA 200.7	0.02	mg/L
Manganese	Dissolved	EPA 200.8	0.001	mg/L
Mercury	Dissolved	EPA 245.1	0.0002	mg/L
Molybdenum	Dissolved	EPA 200.8	0.002	mg/L
Nickel	Dissolved	EPA 200.8	0.002	mg/L
Potassium	Dissolved	EPA 200.7	0.5	mg/L
Selenium	Dissolved	EPA 200.8	0.002	mg/L
Silicon	Dissolved	EPA 200.7	0.05	mg/L

Table 2-3. Analyte List for Active Monitor Well Sampling				
Parameter or Analyte	**Total or Dissolved (1)**	**Method (2)**	**Reporting Limit (2)**	**Units**
Metals - Continued				
Silver	Dissolved	EPA 200.8	0.001	mg/L
Sodium	Dissolved	EPA 200.7	0.5	mg/L
Strontium	Dissolved	EPA 200.7	0.02	mg/L
Thallium	Dissolved	EPA 200.8	0.001	mg/L
Tin	Dissolved	EPA 200.7	0.1	mg/L
Titanium	Dissolved	EPA 200.7	0.005	mg/L
Uranium, Total	Dissolved	EPA 200.8	0.001	mg/L
Vanadium	Dissolved	EPA 200.8	0.002	mg/L
Zinc	Dissolved	EPA 200.8	0.01	mg/L
Radiochemicals				
Gross Alpha	Dissolved	EPA 900.0	1.0	pCi/L
Gross Beta	Dissolved	EPA 900.0	1.0	pCi/L
Radium-226	Dissolved	EPA 903.0	1.0	pCi/L
Radium-228	Dissolved	EPA 904.0	1.0	pCi/L
Thorium-228	Dissolved	HASL 300	1.0	pCi/L
Thorium-230	Dissolved	HASL 300	1.0	pCi/L

Notes: (1) Dissolved constituents are field filtered with a disposable 0.45 micron filter.
(2) EPA laboratory analytical methods and reporting limits are consistent with those provided in Revision 5 of the QAPP; alternative analytical methods identified in the QAPP may also be used.
"mg/L" is "milligrams per liter"
"pCi/L" is "picocuries per liter"

SECTION 3.0
QUALITY ASSURANCE/QUALITY CONTROL

Groundwater monitoring activities are performed pursuant to the QAPP - Revision 5 (ESI and Brown and Caldwell, 2009) and relevant written comments provided by the EPA on groundwater sampling and analysis protocols and methods for the Second-Step HFA (Brown and Caldwell, 2007). The QAPP incorporates the following items: SOPs, equipment calibration and maintenance, independent audit, field and laboratory QC samples, data validation, corrective action, and data completeness. Additional details of the QA/QC procedures specific to the GMP are addressed below.

3.1 Standard Operating Procedures

Groundwater sampling SOPs are detailed, written procedures that are followed during the collection of groundwater samples, and the measurements of water levels and field parameters. The use of SOPs is meant to ensure consistency across multiple sampling events that may be conducted by different personnel. SOPs are included in Appendix E of the QAPP.

3.2 Sample Analysis Validation

The type and reliability of methods used to analyze samples is very important in ensuring that the data are of a known and acceptable quality, and that the data can be used for their intended purpose. The following sections describe the analytical methods that are likely to be used, and the standards and procedures that will be followed to ensure that data are acceptable. This information is described in greater detail in the QAPP.

3.2.1 Data Quality Objectives and Measurement Performance Criteria

The QAPP contains a discussion and summary of data quality objectives (DQOs) and measurement performance criteria for laboratory and field work. Specifically, these include precision, accuracy, comparability, and sensitivity of data. These are generally described as follows.

Precision refers to the degree to which repeated measurements are similar to one another. It measures the reproducibility among individual measurements obtained under prescribed similar conditions. Measurements, which are precise, are in close agreement. The QAPP identifies the measurements that are precise as well as the formula used to determine precision. Precision is generally assessed by the measurement of sample duplicates, matrix spike/matrix spike duplicates (MS/MSDs), and laboratory control sample/laboratory control sample duplicates (LCS/LCSD).

Accuracy is defined as the measurement of the closeness of an individual reading, or the average of a number of readings, to the true value. The accuracy measurement is generally determined by the percent recovery (%R) of a known value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. The variance from the true value represents the bias associated with the accuracy.

Comparability is generally defined as a measure of the confidence with which one data set or method can be compared to another. Comparability of data is achieved by ensuring samples have been collected and analyzed following the same protocols.

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. The QAPP includes a definition of method detection limits (MDLs) and reporting limits (RLs), and identifies how MDLs and RLs have been determined.

3.2.2 Quality Assurance and Quality Control Sampling

Samples are collected at regular intervals for QA/QC purposes. These samples include duplicate, MS/MSD, field blank, and equipment rinse samples. The designations given to QA/QC samples and the associated original samples are documented on the sampling logs and in the logbook.

Duplicate samples are used to compare results from two separate samples taken from the same location at a rate of one duplicate per ten samples (or less). For each duplicate, a second set of bottles is filled following the same procedures as used for the original sample. The duplicate and original sample bottles are filled by alternating the discharge between the bottles after each one-third of the bottle is filled. Duplicate samples are designated by adding the suffix "-FD" to the well name from which the duplicate was collected (e.g., a duplicate sample from B/W-3S is designated as B/W-3S-FD). Wells selected for duplicate analysis change with each sampling event, and are identified on the sampling log.

MS/MSD samples are evaluated for laboratory control and for verification of DQOs. These samples are collected at a rate of one MS/MSD per 20 samples (or less). MS/MSD sampling entails filling twice the number of bottles as a regular sample, and the bottles are given the same sample identification. MS/MSD samples are noted on the sample Chain-of-Custody (COC) form. Wells selected for MS/MSD analysis change with each sampling event, and are identified on the sampling log. MS/MSD samples also are collected by alternating the discharge between the original sample bottles and the MS/MSD sample bottles.

Field blanks and equipment rinsate blanks are collected during each sampling event. Blank samples are used to evaluate if chemicals have been introduced into samples during the purging/sampling procedures. Each blank sample is a full bottle set with a unique sample designation. Field blanks are designated as "FB", whereas equipment rinse blanks are designated as "EQ". Each blank is sequentially numbered in the order collected starting with "-01". The sample bottles are filled with laboratory-supplied deionized (DI) water in the same manner as the original sample. Field blanks are collected at a rate of one blank for every 20 samples (or less). Equipment rinsate blanks are only collected when non-dedicated sampling equipment is used, at a rate of one sample per four work days. Once sampling equipment has been decontaminated, DI water is pumped through the equipment into the appropriate sample bottles. The well locations from where field and equipment rinse blanks are collected are documented on the Groundwater Sampling Log and the field logbook.

SECTION 4.0
MONITOR WELL FIELD SAMPLING PLAN

The groundwater monitoring program involves routinely measuring the depth to groundwater and monitoring the water quality in the set of monitor wells comprising the GMP. This Field Sampling Plan (FSP) presents the specific procedures for conducting these activities including a description of the groundwater monitoring locations, field measurement procedures and criteria, sampling methods, quality control sample protocols, sample container requirements, sample preservation methods, decontamination procedures, and documentation of sampling activities. This FSP is written as a field manual, which provides sampling personnel with easy-to-use procedures and methods for consistently collecting quality, representative groundwater samples and measurements. Sampling personnel must understand and use this FSP as a field manual during groundwater sampling events, consistently follow the specified procedures and protocols, and clearly document deviations from the FSP along with reasons for the deviations.

Monitor wells are listed in Appendix A along with available construction details, and shown on Plate 1. Borehole and well construction logs are provided in Appendix B. Appendix C identifies the frequency for obtaining manual water level measurements and water quality samples at each individual monitor well. Appendix D provides pump specifications and other information pertinent to sampling the wells such as the pump location within the well, pumping cycle settings, and discharge rates during previous sampling events. A Field Sampling Event Data QC Checklist (Appendix E) must be reviewed before mobilizing to the Site.

FSP activities are conducted in accordance with the GMP and applicable regulations and standards, including those of the EPA and the Office of Safety and Health Administration (OSHA). FSP methods and procedures described herein are consistent with the Site-Wide HASP (Brown and Caldwell, 2009a), the current version of the QAPP - Revision 5 (ESI and Brown and Caldwell, 2009), and SOPs applicable to collecting groundwater samples from Site-wide groundwater monitoring wells. Parts of the QAPP and HASP that relate to groundwater sampling activities are incorporated by reference or specifically reiterated in the FSP.

4.1 Groundwater Level Monitoring

Depths to groundwater in the wells are measured manually on a monthly basis (instruments are decontaminated prior to quarterly sampling). Groundwater levels are measured to the nearest 0.01 foot relative to the reference point at the well (i.e., the top of the inner casing). Monthly measurements are taken within a three-day (or shorter) period, and are compared to the most recent water level obtained for the well. If the measurements differ by more than 0.5-foot, the depth to water is measured a second time for verification purposes.

As indicated in Section 2.2, water levels are electronically measured at 30 or 60 minute increments in monitor wells listed in Table 2-2 using dedicated pressure transducers/data loggers permanently. More detailed procedures for monthly and daily groundwater level monitoring are in SOP-16 and SOP-21, respectively, of the QAPP.

Water levels in the monitor wells are measured using a decontaminated water level indicator. If multiple meters are used, the calibration of the meters is checked so that the same water level measurements are indicated. The following procedures are followed each time the water level is measured in a monitor well:

1. Turn on water level meter. Depending on the condition of the water level meter, the sensitivity may have to be adjusted by turning the power switch dial to the desired sensitivity level. Typically, the water level meter works best adjusted to a low sensitivity (2 to 3).
2. Press the appropriate button to test the meter.
3. Open/unlock well head.
4. Don a new pair of nitrile gloves and a pair of work gloves.
5. Lower the water level meter probe into the well. Hold onto the handle or use your hand as a brake to limit the speed of the probe descent (wear work gloves).
    - Hold the spool directly over the well. Do not let the cable scrape on the top of the casing. Doing so may cause irreparable damage to the cable.
    - Do not let the probe free fall in the well as this may cause the probe and cable to become tangled in the well. It may also cause the probe and cable to lower deeper within the water column resulting in the need to decontaminate the immersed length of cable. The sudden stop may damage to the meter.

- Most wells have dedicated pumps in place; great care should be taken so that the probe does not get tangled with the pump tubing in the well. If the probe cannot be lowered to the water level, the opposite side of the well should be tried.
- Leave at least five complete wraps on the spool. For example, the maximum measurable water level with a 150-foot meter is approximately 145 feet.
- Measure the static water level for a well before purging, sampling, or inserting another instrument into the water column.

6. Water level readings are measured relative to the surveyed mark on the top of the inner casing.
7. When the buzzer sounds, and the light turns on, stop the descent of the probe. Gently raise the probe until the buzzing stops. Gently lower the probe until the buzzing starts again and stop. The cable should be immediately next to the measuring mark from now until the final reading is measured. If the buzzer stays on, or is very weak, adjust the sensitivity.
8. Without changing the hold on the cable, raise the probe out of the water and retest the measurement.
9. Keep adjusting the hand location until two identical readings are noted. Identical readings will be the same to 0.01 of a foot.
10. If the numbers on the cable can be observed, read the measurement at the mark to the nearest 0.01 foot.
11. If the numbers on the cable cannot be observed, place fingers around the cable at the location where the buzzer sounds relative to the reference point, pull the cable out without moving your hand with respect to its location on the cable, and record the reading.
12. If the two readings are within 0.01 foot, record the depth to water reading on the appropriate form.
13. If the measurers' hand slips on the cable, or there is any question to the validity of the reading, the water level should be remeasured.
14. Remove the probe from the well. Do not let the cable rub against the top of the casing during removal. Take note where the cable becomes wet. The cable and probe below this point needs to be decontaminated.
15. Decontaminate the probe and two feet (or the appropriate length if more than two feet immersed in water column) of cable by immersing in an Alconox® solution followed by immersing in tap water and deionized water rinses, respectively.
16. Spool the remaining cable.
17. Secure the probe in the holder.
18. Turn off water level meter.
19. Close/lock well or begin sampling procedures.

4.2 Groundwater Quality Monitoring

Groundwater quality monitoring includes analyzing samples both in the field and in contract laboratories. Only meters that were calibrated at the beginning of the work day are used to measure field water quality parameters, which include temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, and specific conductance (SC). Field water quality parameters are measured in a flow-through cell at regular intervals (typically every five minutes) while the well is being purged during the low-flow process. The three wells (WW-36B, WW-40B, and WW-59B) sampled using the well-volume purging method are not tested for ORP or DO.

Samples analyzed by the contract laboratories are collected into and shipped in new sample bottles provided by the laboratory. Standard inorganic chemical analysis is conducted by TestAmerica Irvine (TA-I) in Irvine, California, whereas radiochemical analysis is conducted by TestAmerica Richland (TA-R) in Richland, Washington. Laboratory analytical parameters are listed in Table 2-3.

4.2.1 Groundwater Sample Collection Procedures

The goal of groundwater sampling is to collect samples that are representative of in-situ groundwater conditions and to minimize changes in groundwater chemistry that would adversely affect analyte concentrations during sample collection and handling (EPA, 1996 and 2002). To achieve this goal, groundwater samples are collected from the majority of the monitor wells using low-flow (minimal drawdown purging and sampling) procedures and Site-specific procedures developed in conjunction with the EPA based on previous sampling experience and results. The Site-specific, low-flow, minimal drawdown purging and sampling procedures are discussed in Section 4.3.1.1. However, standard well-volume purging and sampling methods are required at three monitored water supply wells (WW-36B, WW-40B, and WW-59B), as discussed in Section 4.3.1.2.

4.2.1.1 Low-Flow Minimal Drawdown Method

In each monitoring well, water is purged and samples are collected in a similar manner during each sampling event. In wells where low-flow methods are followed, various types of pumps are used to purge and collect groundwater samples from the wells. Currently in most of the low-flow wells, a permanently-installed bladder pump dedicated to the respective well is used to collect samples. In the eleven pumpback wells (PW-1S through PW-11S), continuously-operating dedicated submersible pumps were used for sample collection. Following shutdown of the PWS on March 25, 2009 (Table 1-1), the dedicated groundwater extraction pumps were removed for maintenance and repair, and a non-dedicated bladder pump has been used to sample the PWS wells. A peristaltic pump currently is used for low-flow purging and sample collection at the following nine wells: LC-MW-1S, LC-MW-2S, LC-MW-3S, LC-MW-5S, W5AA-3S, USGS-2BS, USEPA-2S, LEP-MW-5S, and LEP-MW-7S. New tubing is used at each well in conjunction with the peristaltic pump.

The following procedures are followed when purging and sampling a monitor well using the low-flow, minimal drawdown method:

1. Arrive at well location and start to fill out **Groundwater Sampling Log**. Fill out: Date, Time, Well ID, and Sampler. Leave no blank spaces on the form.
2. Put on new nitrile gloves.
3. Using a decontaminated water level meter, measure and record the depth to water from the measuring point to an accuracy of 0.01 foot. The measuring point is marked on the top of the inner casing.
4. Connect and tighten all tubing and hoses.
5. Verify that the pressure on the control box is at the lowest setting by turning the throttle valve counter-clockwise.
6. Start the power source for compressed air (gasoline-powered generator, direct current (DC) generator, or open valve on cylinder of compressed carbon dioxide (CO_2)). Mark the power source on the **Groundwater Sampling Log.**
7. Adjust the initial cycles per minute and refill/discharge times on the control box to the settings indicated on the table in Appendix D of this GMP.
8. Press "Start" on the control box to start purging the well. Increase the base pressure to the specified setting in Appendix D. When water initially discharges, make sure there are no bubbles in the discharge line. Bubbles indicate that there may be a leak in the lines or

in the bladder. If there are bubbles, try to adjust the discharge time and/or pressure. If the bubbles remain, the pump must be removed and inspected. The discharge should continue until the end of the discharge cycle. If it stops early, it means the bladder is being emptied before the cycle ending. This puts unnecessary wear and tear on the bladder.

9. Measure and record the pumping rate in milliliters per minute (ml/min) by collecting the discharged water in a beaker or graduated cylinder. Adjust the base pressure, the cycles per minute, and/or the refill/discharge times as needed so that the flow rate is between 100 and 500 ml/min.
10. Once maximum discharge rate is achieved without lowering water level more than 0.3 feet, record the final purge settings on the **Groundwater Sampling Log** for use in future sampling events. The purge time starts when the settings are adjusted.
11. Collect purge water into five-gallon plastic containers as needed.
12. Connect the discharge line to the flow-through cell.
13. After the flow-through cell is connected, water quality parameters (pH, DO, ORP, SC, temperature, and turbidity) and depth to water (DTW) are measured and recorded generally at five minute intervals. The relative percent difference (RPD) and delta calculations are conducted and recorded between the readings.
14. When the well has been purged for 60 minutes or field water quality readings are all stable, the well is ready to be sampled. The field parameters are considered stable when three consecutive field measurements meet the criteria listed in Table 4-1. If the well has been purged for 60 minutes and the field parameters have not stabilized, it is noted on the sampling log, and the well is sampled.
15. Collect a groundwater sample following the sample collection procedures in Sections 4.3.3 and 4.3.4.
16. Stop the pump.
17. Place the bottles for TA-I into a plastic bag and into a cooler with ice. The bottles for TA-R do not need to be stored on ice.
18. Disconnect the tubing from the wellhead and secure the well cover.
19. Decontaminate the water level meter following the procedure indicated in Section 4.0.
20. QA samples are collected at regular intervals; these are identified in the Well Sampling Specifications prepared for each event. Duplicate samples are collected at the rate of one duplicate per ten samples (or less). MS/MSD and field blank samples are collected at a rate of one sample per 20 samples (or less). An equipment rinse blank is collected at a rate of one sample per day for the four days where a non-dedicated pump is used to collect the samples from the Pumpback Wells. The field and equipment rinse blanks are collected at every 20th monitor well location using laboratory-supplied deionized water. Duplicate samples and MS/MSD samples typically are collected by alternating the flow between the bottles. Generally, after a bottle is filled 1/3 of the way, the discharge should be directed to the next bottle. Continue this process until the bottles are filled.

21. Turn off the power supply for compressed air. Disconnect the regulator from the CO_2 tank and screw the protective cover onto the cylinder.
22. Pack up the equipment and go to next well.
23. The analytical testing program includes nitrates and nitrites, the hold time for which is 48 hours. Samples are delivered to the laboratory daily, and the procedures for cooler delivery in Section 4.6 are followed.
24. As needed, discharge the purge and decontamination waters to the lined Phase I evaporation pond on the Site.

Regardless of the purging/sampling equipment, the respective pumps and dedicated tubing are positioned at the same depth in each well for each sampling event. The pump/tubing depths in each well are included in Appendix D. The purge rates for each well typically are similar during successive sampling events. The purge rate for the low-flow method wells initially can be set to the rate used in previous events and adjusted as needed based on current groundwater conditions.

4.2.1.2 Standard Well Volume Method

At the three monitored water supply wells (WW-36B, WW-40B, and WW-59B), production pumps are permanently set in each well. Water from WW-40B and WW-59B is purged by running the pump continuously (at or near the maximum possible discharge rate) for about eight hours and four hours, respectively, before sample collection. Because WW-36B is a water supply well for the Weed Heights community, the pump runs continuously (i.e., is being continuously purged) and a grab water sample is collected. ARC continues to evaluate whether the equipment used to purge and collect samples from a specific well will need to be modified based on an ongoing assessment of groundwater conditions at the Site.

These three wells generally are purged and sampled using the following procedures:

1. Arrive at well location and start to fill out **Groundwater Sampling Log**. Fill out: Date, Time, Well ID, and Sampler. Leave no blank spaces on the form.
2. Put on nitrile gloves.
3. Connect all wires and hoses. CAUTION: Power switch on pump cable MUST be in off position before cable is plugged into the generator outlet.
4. Start generator. If it is cold, let it run for at least five minutes before starting the pump.

5. Start pump (pump cable switch to "on" position).
6. Measure and record field parameters of temperature, pH, SC, and turbidity on the sampling log upon sample collection at WW-36B, and at the beginning, middle, and end of the 8- and 4-hour purging intervals at WW-40B and WW-59B, respectively.
7. Collect a groundwater sample following the procedures in Sections 4.3.3 and 4.3.4.
8. Stop the pump (use the "OFF" switch on the pump power cable).
9. Place the bottles for TA-I into a plastic bag and into a cooler with ice. The bottles for TA-R do not need to be stored on ice.
10. Pack up the equipment and go to next well.
11. The analytical testing program includes nitrates and nitrites, the hold time for which is 48 hours. Samples are delivered to the laboratory daily, and the procedures for cooler delivery in Section 4.6 are followed.

4.2.2 Field Parameter Measurements and Stabilization

Measurements of field parameters are recorded during purging to determine when stabilization has occurred and representative formation water is being sampled. Field parameters are measured in a flow-through cell at regular intervals (typically every five minutes) during the low-flow purging process, and purging continues until the field parameters have stabilized based on the criteria summarized in Table 4-1 or until the maximum purge volume/time is met.

Table 4-1. Field Parameter Stabilization Criteria for Monitor Well Purging and Sampling

Parameter	Low-Flow Method	Well-Volume Method
pH	+/- 0.1 S.U.	+/- 0.1 S.U.
Conductivity	+/- 3%	+/- 3%
Temperature	+/- 3%	+/- 3%
Dissolved Oxygen	+/- 10% or +/- 0.1 mg/l if <2.0	Not Measured
ORP	+/- 10% or +/- 10 mV if < 100	Not Measured
Turbidity	<10 NTU or +/- 10%	<10 NTU or +/- 10%
Drawdown	<0.3'	No Criteria
Pumping rate	100-500 ml/min	No Criteria
Volume	No Criteria	3 to 5 casing volumes
Time	Maximum of 60 min	No Criteria

Notes: All percentages are relative percent difference.
For high volume wells, the 3 to 5 casing volume is not required.

These criteria are also listed on the well sampling forms. For wells WW-40B and WW-59B, field parameters are measured at the beginning, middle and end of the purging intervals for these wells. A grab groundwater sample is collected from WW-36B because the pump runs continuously as it provides water to the Weed Heights community. Field parameters are measured once in WW-36B at the time of sample collection.

4.2.3 Sample Filtration and Collection

When the stabilization criteria previously described are met, a groundwater sample is collected. Groundwater samples are collected from the pump discharge line directly into laboratory-supplied containers appropriate for the specific analysis being conducted. Each sample bottle is filled by tipping the sample container at a slight angle and allowing a steady stream of water to run down the inner wall. The discharge tube is held close to the sample container, but is not allowed to touch it. The sample bottles for TOC are filled such that there is no headspace in the bottle. The sample bottles containing acid preservative are filled with water filtered in the field with a 0.45 micron (µm) disposable filter (these are filled last). A new disposable 0.45 µm pore size filter is used at each well. The filter is attached to the discharge tubing such that the arrow on the filter is aligned with the direction of flow. The filter is flushed before use by allowing two cycles of water sample to discharge through the filter before filling the sample containers. Specific procedures for collecting groundwater samples after purging and parameter stabilization include the following:

1. Fill out the sample bottle labels using a pen with black waterproof ink. Bottles for “dissolved” metals and radiochemical analysis have “FILTERED” indicated on the label. The appropriate preservative is placed in the bottle by the lab. Times on sample containers are in military time (i.e., 1300 instead of 1:00 pm).
2. Disconnect the discharge line from the flow-through cell.
3. Fill the sample bottle for physical parameters and cations/anions, followed by the amber glass bottle for TOC analysis.
4. Once the unfiltered samples are collected, attach a new 0.45 micron (µm) filter to the discharge tubing such that the arrow on the filter is aligned with the direction of flow. When attaching the filter, care is taken to keep the ends of the filter clean.

5. Flush the filter by allowing two cycles of water sample to discharge through the filter. Fill the sample bottle for dissolved metals analysis and the bottles for radiochemical analysis. Care is taken to prevent unfiltered water from dripping into the sample bottle. Do not overfill the bottles.
6. Stop the pump.
7. Place the bottles for TA-I into a plastic bag and into a cooler with ice. The bottles for TA-R do not need to be stored on ice.

Regardless of the sampling method (i.e., low-flow versus volumetric), other general procedures that are followed during sampling include:

- Do not rinse the sample bottles before filling.
- Collect water sample from the pump discharge line directly into laboratory-supplied containers appropriate for the specific analysis being conducted.
- Fill each sample bottle by tipping the sample container at a slight angle and allowing a steady stream of water to run down the inner wall. Hold the discharge tube close to the sample container, but do not touch it.
- Fill the glass bottle for TOC analysis so there are no air bubbles in the sample. Tap the bottle against your knuckle after the cap has been put on it to make sure there are no bubbles.
- Open only one sample container at a time. Immediately replace the cap of the container and make sure the label is completed before starting to fill the next bottle.
- When there are multiple similar bottles (such as for radiochemical analysis), alternate filling the bottles after each 1/3 of the bottle has been filled.
- Minimize the contact of extraneous contamination with sample containers and equipment by sampling up wind or removing contaminants before opening containers. Common contaminants at Yerington include dust or other particulate matter, and possibly perfume, bug spray, sun tan lotion, sharpie pens, WD-40, and engine fumes.
- Immediately put the cap on each bottle after filling it.
- Place filled sample bottle into an iced cooler (except for radiochemical analysis) and enter sample information onto the appropriate COC form.

4.2.4 Sample Containers, Preservation, and Holding Times

Table 4-2 lists the number of sample bottles, the laboratory analyte(s), the type and size of the sample containers, the preservatives, the type of filter used, the holding times, and the analytical laboratory for groundwater samples that are collected from the monitoring wells. All samples are collected into new bottles supplied by the laboratory. Preservatives are added into the sample containers by the laboratory before use at the Site. Each preserved container is clearly marked with the appropriate preservative by the laboratory. Once the sample is collected in the field and shipped back to the laboratory, the pH of the preserved sample is checked by the laboratory. Sample preservation methods are summarized in SOP-02 of the QAPP.

Table 4-2. Sample Parameter Groups, Container Sizes, Preservation Methods, Holding Times, and Analytical Laboratories

Qty.(1)	Analyte(s)	Type-Size	Preservative	Filter	Holding Time	Lab
1	Physical parameters and cations/anions(2)	Polyethylene-500 ml	None	No filter	48 hours for nitrate and nitrite, 14 days for alkalinity, 28 days for others	TestAmerica-Irvine
1	Metals(3)	Polyethylene-500 ml	Nitric Acid to pH < 2	0.45 µm	28 days for mercury, 6 months for others	TestAmerica-Irvine
1	Total Organic Carbon	Amber Glass-250 ml	Hydrochloric Acid to pH < 2	No filter	28 days	TestAmerica-Irvine
7	Radiochemicals(4)	Polyethylene-1000 ml	Nitric Acid to pH < 2	0.45 µm	6 months	TestAmerica-Richland

Notes: (1) Number of sample bottles filled for analyte(s).
(2) Physical parameters and cation/anions listed in Table 2-3. Total Organic Carbon not included.
(3) Metals listed in Table 2-3.
(4) Radiochemicals listed in Table 2-3.
“ml”=milliliters
“µm”=micron

4.3 Documentation of Field Activities

All field activities, including daily activities, sample locations and identification numbers, and significant observations or events, are described in detail on the appropriate forms following procedures in SOP-03 of the QAPP. The activities and details, complete with time tags, also are written in the bound field logbook. Deviations from this FSP, the QAPP, SOPs, or other guidance documents are specifically documented in the logbook. Specific forms for water level monitoring, equipment calibration, and groundwater sampling are used (Appendix F). The data are intended to record events in sufficient detail to allow personnel to reconstruct events that transpired during the life of the project. Entries are written in black indelible ink to allow preservation of information. A detailed description of logbook requirements is included in SOP-03 in the QAPP. The general documentation requirements are summarized as follows:

1. There will be no blank lines.
2. There will be no pages left blank.
3. Entries will be legible.
4. Entries will be written in indelible black ink.
5. Mistakes will be corrected by drawing a single line though the error. Corrections will be initialed. No entries will be obliterated for any reason.
6. The tops of pages will be numbered sequentially and dated. The sampler will initial and date the bottom of each page and sign the last page for each day.
7. Opinion or subjective material will not be entered into the logbook.

Each day, the following data are recorded in the logbook:

1. Project name and date.
2. Weather (temperature, cloudiness, barometric pressure, wind).
3. Water quality and turbidity meters used (type, model).
4. Person calibrating meter(s).
5. Calibration results (buffers used with manufacturer, lot numbers, and expiration dates).
6. Problems calibrating meters.

At each well, the following data is recorded in the logbook:

1. Well name and arrival time.
2. Person(s) sampling.
3. Purging method (low-flow or well volume).
4. Filter information (manufacturer, pore size).
5. QA/QC samples collected and the sample designation.
6. Samples preservation (ice, acid preservative).
7. Equipment decontamination procedures.
8. Decontamination/purge water disposal.
9. Comments (difficulties, questionable data, deviations from this FSP, etc).
10. Problems with field meters.
11. Visitors (name, title, organization).

4.4 Sample Identification, Documentation, and Custody

Collected samples are labeled in water-proof ink with the following information: sample name, date and time of collection, name or initials of person collecting the sample, and analyte list. The label also indicates if the sample was filtered in the field. Similar information is also entered on the COC form, which remains with the respective collected sample through delivery to the analytical laboratory. Samplers maintain proper custody of their respective samples until delivery to the laboratory, or the samples are relinquished to another party. A sample is considered to be under a person's custody if:

- the sample is in the person's physical possession;
- the sample is in view of the person after that person has taken possession of the sample;
- the sample is secured by that person so that no individual can tamper with the sample; or
- the sample is secured by that person in an area that is restricted to authorized personnel.

The information required on the sample labels is also entered on the COC form, which remains with the collected samples through delivery to the analytical laboratory. One COC form is completed for each collected sample. Completed COC forms are delivered with the samples to the appropriate analytical laboratory (TA-I or TA-R). Because two labs are being used for groundwater analysis, each sample is listed on two COC forms (one for each lab). Each COC form must match the samples included in the associated cooler. The COC forms include the following information:

- Project name.
- Unique sample identification number.
- Unique COC number.
- Sample collection date and time.
- Sample matrix.
- Number and type of containers submitted.
- Preservation method, if applicable.
- Analyses requested for each sample.
- Special handling or analysis requirements.
- Courier shipment tracking number.

- Dated signature of the person collecting the samples.
- Dated signature(s) of persons, other than the sampler, involved in the delivery of the samples to the laboratory.
- Dated signature of the laboratory acknowledging receipt of the collected samples.

The COC form is filled out and signed in black indelible ink. The appropriate COC forms are included in a cooler to match the samples in the cooler. Before sealing a cooler with tape, the COC forms are double-checked against the samples in that cooler. The COC number and the date and time of delivery to the laboratory are noted in the field logbook. A copy of the COC form is delivered to and retained by the Brown and Caldwell Project Manager.

4.5 Sample Packing and Transport

Once collected, groundwater samples are packed for transport to the analytical laboratory using a courier service via overnight air and standard ground delivery. As indicated in Table 4-2, the samples for radiochemical analysis are analyzed by TA-R, whereas the remaining samples are analyzed by TA-I. Because the hold time for analysis of nitrates/nitrites is 48 hours, samples are shipped on ice overnight for delivery to TA-I the next business morning. Samples for radiochemical analysis are shipped without ice to TA-R via ground delivery. Sample handling and transport procedures are summarized as follows and also provided in SOP-01 in the QAPP.

1. COC forms are shipped in each set of coolers, and the forms need to match the bottles included in the cooler. The sampler needs to sign the COC when the samples are relinquished to the courier or the person delivering the coolers to the courier. The last person controlling the samples should relinquish the samples by signing and dating the form. A copy of the COC is retained by the sampler for storage in project files in Brown and Caldwell's Carson City office
2. Samples analyzed by TA-I will be stored and shipped on ice, whereas ice is not needed for samples shipped to TA-R.
3. In an empty cooler, place protective packing material (bubble wrap) on the bottom and sides of the cooler.
4. Place the sample bottles for TOC analysis in a bubble wrap bag provided by the laboratory.
5. Place the sample bottles in the cooler such that there are no large voids between the sample bottles.

6. Count the number of samples in the cooler and the number of COCs. If not the same, empty the cooler and start over.
7. Fill new resealable plastic bags (i.e., Ziploc® bags) with ice and check for rips or tears in the bag. Place the bagged ice in a second resealable plastic bag. Place the ice-filled bags in the cooler for shipment to TA-I.
8. Cover the bottles and ice with bubble wrap. Ice should not be used to secure bottles.
9. Place the COCs that correspond to the samples in the cooler in a resealable plastic bag and place on top of the bubble wrap.
10. Close the cooler and tape the cooler closed by wrapping tape around the cooler 3-4 times. Tape the spigot closed.
11. Place custody seals on the right and left front side across the gap from the lid to the cooler.
12. Coolers shipped to TA-I contain ice as a preservative and are delivered via overnight air. If samples are shipped on a Friday afternoon, request a Saturday delivery to the lab on the courier form. Coolers shipped to TA-R are delivered via ground service.
13. Deliver the samples to either the TA-I or the TA-R lab at the following addresses:

TestAmerica Irvine
17461 Derian Avenue, Suite 100
Irvine, CA 92614-5817
(949) 261-1022

TestAmerica Richland
2800 George Washington Way
Richland, WA 99354
(509) 375-3131

4.6 Field Equipment Calibration

The field water quality meters are calibrated following the manufacture's protocol and as described in SOP-04 of the QAPP. Except for temperature, each field parameter measured during purging (pH, SC, DO, ORP, and turbidity) is calibrated at the start of each day, and checked immediately after calibration, and at any time the meter is believed to be operating poorly. Calibration check readings are recorded on the field calibration form. A meter is recalibrated when the reading is not within +/-10% of the standard solution or +/-0.20 pH units of the buffer solution. If the meter cannot be recalibrated, it is not used, and is sent to the manufacturer/distributor for repair.

At the end of each day of sampling, potential drift in parameter readings is evaluated by measuring standards for each parameter. The drift readings also are recorded on the field calibration form. Acceptable performance of the meter(s) is indicated by a drift of +/- 0.20 standard units for pH and +/- 10% for the remaining calibrated parameters.

Meter Calibration: The water quality meters are calibrated following the manufacture's protocol and as described in SOP-04 of the QAPP. Except for temperature, the meter used for each field parameter measured during purging (pH, SC, DO, ORP, and turbidity) is calibrated at the start of each day, and checked immediately after calibration, at the end of each day, and at any time the meter is believed to be operating poorly. Calibration check readings are recorded on the field calibration form; a copy of which is included in Appendix F. A meter is recalibrated when the reading is not within +/-10% of the standard solution or +/-0.20 pH units of the buffer solution. If the meter cannot be recalibrated, it is not used, and is sent to the manufacturer/distributor for repair. At the end of each day of sampling, potential drift in parameter readings is evaluated by measuring standards for each parameter. The drift readings also are recorded on the field calibration form. Acceptable performance of the meter(s) is indicated by a drift of +/- 0.20 standard units for pH and +/- 10% for the remaining calibrated parameters.

Fresh calibration solutions are used for calibration at the start of each work day. The solutions may be saved for calibration checks and subsequent calibrations provided there is no question to the integrity of each solution. If a solution is suspected of being contaminated, it is discarded and fresh solution is used. Solutions are saved in clean containers clearly marked with their contents and are not poured back into the original containers. The zero-oxygen solution for DO cannot be reused.

SC: The SC reading on each meter is calibrated at the beginning of each work day using one of the following standard solutions: 447 microsiemens per centimeter (µS/cm), 1413 µS/cm, 8974 µS/cm, or 15,000 µS/cm. Historical SC readings at a specific grouping of wells anticipated to be sampled that work day are reviewed to select the standard solution with a similar SC value to which to calibrate. The actual conductivities of the calibration solutions may vary slightly depending on the manufacturer.

pH: The pH measurement on each meter is calibrated using a three point calibration (4.00, 7.00, and 10.00). The pH values to which a meter is calibrated are slightly adjusted as needed to compensate for the temperature of the standard solution.

DO and ORP: DO and ORP are single point calibrations. The DO reading is calibrated to open air and checked using a zero-oxygen solution, whereas the ORP is calibrated to a standard solution of 220 millivolts (mV). The ORP value to which a meter is calibrated is slightly adjusted as needed to compensate for the temperature of the standard solution.

Turbidity: The turbidity meter is calibrated using standard solutions of 0.02, 10, and 1000 nephelometric turbidity units (NTUs).

4.7 Sample Documentation and Records

Field activities, including daily activities, sample locations and identification numbers, and any significant observations or events, are described in detail on the appropriate forms in the field notebook following procedures in SOP-03 of the QAPP. The activities and details, complete with time tags, are also written in the bound field logbook. Any deviations from this GMP, the QAPP including the SOPs, or any other guidance documents are specifically documented in the notebook and/or logbook. There are individual forms for water level monitoring, equipment calibration, and groundwater sampling. Copies of these forms are included in Appendix F. The data are intended to record events in sufficient detail to allow personnel to reconstruct events that transpired during the life of the project. Entries are written in black indelible ink to allow preservation of data. Mistakes are corrected by drawing a single line though the error and the author initialing next to the deleted error. No entries will be obliterated for any reason. A more detailed description of logbook requirements is in SOP-03 of the QAPP.

4.8 Equipment Decontamination

Water level monitoring and non-dedicated groundwater sampling equipment that comes in contact with the groundwater or subsurface at the Site are cleaned prior to use and between sampling locations following procedures indicated in SOP-05 in the QAPP. Except for the non-dedicated bladder pump used on the eleven pumpback wells, decontamination is not needed for the bladder pumps and associated tubing dedicated to specific wells. The non-dedicated bladder pump is decontaminated by pumping a series of solutions through the pump. The solutions are pumped in the following order: non-phosphate detergent (Alconox®), tap water, a weak nitric acid solution, and deionized water. The last two feet of the water level meter cable is decontaminated by immersion in a non-phosphate detergent solution followed by immersion in tap water and deionized water rinses, respectively. After decontamination, equipment is stored and/or transported under clean conditions. Typically, equipment is stored in a clean plastic bag until reuse.

4.9 Handling and Disposition of Investigation-Derived Wastes

Wastes generated during field investigations are handled following procedures indicated in SOP-06 of the QAPP. Except for three water supply wells (WW-36B, WW-40B, and WW-59B), purge water generated from the monitor wells is collected into five-gallon plastic containers and discharged to the lined Phase I Pond on the Site. Purge water associate with sampling of WW-40B and WW-59B is discharged to the ground surface where it is allowed to flow toward the Yerington Pit Lake. Groundwater extracted at WW-36B goes to Weed Heights and, thus, there is no purge water to manage.

SECTION 5.0
REPORTING REQUIREMENTS AND SUBMITTAL SCHEDULE

GMP reporting requirements are specified in Section 6.0 of the SOW and include: 1) notification of a significant increase of any Site-related chemicals of potential concern (COPC); 2) Monthly Status Reports; 3) Quarterly Site-Wide Groundwater Monitoring Reports (Quarterly GMRs); and 4) Annual Site-Wide Groundwater Monitoring Reports (Annual GMRs). Also pursuant to the SOW, the GMP will be updated annually, as necessary, to document any EPA-approved modifications to the monitoring program for the next year that may have been presented in the Annual Site-Wide Groundwater Monitoring Reports. The various reporting requirements are discussed further in the following sections, along with a proposed schedule for report submittal.

5.1 Notification of Significant Increase in Concentration

Pursuant to Section 6.0 of the SOW, the EPA RPM will be notified by telephone within 24 hours of the discovery of a significant increase of a Site-related COPC in groundwater underlying the Site. As stated in the SOW, a significant increase is defined as equaling or exceeding twice the concentration from the previous sampling event. Discovery of the increase is defined in the SOW as receipt of an analytical report from the laboratory. ARC notes that this notification requirement will necessarily rely on data that have not been validated pursuant to the QAPP. Consequently, initial data interpretations may be reversed once the data have been validated. Also, subsequent quarterly monitoring results may also reverse the initial data interpretation.

5.2 Monthly Status Reports

Monthly Status Reports are submitted pursuant to the SOW and this GMP via electronic mail on or before the tenth day of each month.

5.3 Quarterly Site-Wide Groundwater Monitoring Reports

A report documenting each quarterly sampling event is submitted to the EPA within thirty (30) days of data verification/validation, which is conducted in accordance with the procedures specified in Section 8.0 of the QAPP- Revision 5 (ESI and Brown and Caldwell, 2009). These Quarterly GMRs include:

- a description of the monitoring activities conducted during the previous quarter;
- a chronological summary of water level measurements and water quality analyses for all monitor wells (including wells periodically or no longer sampled);
- a groundwater flow map or maps using the elevation data obtained during the quarterly sampling event;
- maps illustrating the distributions of pH (field), sulfate, and uranium;
- a discussion of the distribution of COPCs in Site groundwater;
- a discussion of any QA/QC issues that arose in the previous quarter; and
- a discussion of the effectiveness of the PWS.

Also, EPA comments on any quarterly report will be addressed in the subsequent quarterly report. A separate Quarterly GMR is not prepared for the fourth quarter sampling event. Instead, information from the fourth quarter sampling event is incorporated directly into the Annual GMR.

5.4 Annual Site-Wide Groundwater Monitoring Report

The Annual GMR includes elements required by the SOW for the Quarterly GMRs and also includes the following:

- a description of the scope and objectives of the monitoring program;
- a description of the scope and objectives of the monitoring program;
- a summary of historical Site-related investigation and monitoring activities;
- total volume of groundwater extracted and mass of contaminants removed;
- a description of groundwater investigation activities conducted during that year;
- identification of new COPCs or changes in COPC distribution; and
- recommendations for changes or additions to/deletions from the monitor and extraction well network, including changes to the monitoring frequency for specific wells.

As required by the SOW, this GMP will be updated annually, as necessary, to document EPA-approved modifications to the monitoring program for the next year that may be presented in the Annual GMRs. The Annual GMR addressing the monitoring activities for a specific year is submitted on or before March 31st of the following year.

SECTION 6.0
FUTURE MODIFICATIONS TO THE GROUNDWATER MONITORING PLAN

Future modifications of the GMP may include elimination or addition of monitoring points, changes to the frequency for groundwater level and water quality monitoring, elimination or addition of laboratory analytical parameters, and possibly other modifications (e.g., recommendations to abandon/decommission certain wells). The process for modifications to the GMP is presented as follows.

6.1 Elimination or Addition of Monitoring Points

The decision process for permanently eliminating wells included in the monitoring network will take into consideration the objectives of the GMP, rationale for initially including the well within the network in addition to the results of groundwater data analysis, flow and spatial analysis modeling if conducted, risk estimates, etc. to determine if the well continues to contribute useful data to the GMP, and related decision-making for the Site. Future wells installed as part of individual OU-specific RIs will be considered for inclusion in the GMP after four quarters of monitoring data have been collected pursuant to the OU-specific investigation.

6.2 Changes to Monitoring Frequencies

Similarly, the decision process for changing the frequency of groundwater elevation and water quality monitoring will take into consideration the objectives of the GMP, rationale for the initial monitoring frequency, and temporal variability in groundwater elevation and chemical data to determine if a change is warranted.

6.3 Elimination or Addition of Laboratory Analytical Parameters

Decisions on elimination or addition of laboratory analytical parameters for groundwater monitoring will be based on their presence/absence, magnitude with respect to background concentration ranges, spatial distribution, temporal variability, general suitability as indicators of mine-related groundwater, and use in assessing potential risk. Criteria that will be applied to determine which parameters should be eliminated include:

- Analytes that are not detected above the laboratory reporting limit during four consecutive quarterly sampling events;
- Analytes that are infrequently detected (e.g., detected in < 5% of the samples from a given well) and/or when detected are present at concentrations that are only slightly above laboratory reporting limits;
- Analytes that have a limited spatial distribution, are not detected in off-Site groundwater at concentrations that exceed background, and are redundant with other analytes for providing information on spatial distribution and temporal variability of contaminant plumes;
- Analytes that remain below their respective drinking water standard during four consecutive quarterly sampling events, and do not exhibit a statistically significant increase in magnitude;
- Analytes for which there is no drinking water standard, do not exhibit a statistically significant increase in magnitude, and are not typically associated with the ore or waste products of a porphyry copper deposit; and
- Analytes that are not typically associated with copper ore processing, are not considered "indicator parameters", have not exceeded drinking water standards during the previous year, and have been reported at generally low levels shall be recommended for elimination.

SECTION 7.0
HEALTH AND SAFETY

GMP field activities are conducted in accordance with the revised HASP for the Site (Brown and Caldwell, 2009a). The HASP identifies, evaluates, and prescribes control measures for health and safety hazards, including radiological hazards, and describes emergency response procedures for the Site. HASP implementation and compliance is the responsibility of Brown and Caldwell, with ARC taking an oversight and compliance assurance role. Copies of the HASP are located at the Site, in ARC's La Palma, California office, and in Brown and Caldwell's Carson City, Nevada office. The HASP includes:

- safety and health risk or hazard analysis;
- employee training requirements;
- personal protective equipment (PPE);
- medical surveillance;
- site control measures (including dust control);
- decontamination procedures; and
- emergency response.

The HASP includes a section for Site characterization and analysis that would identify specific Site hazards and aid in determining appropriate control procedures. Required information for Site characterization and analysis includes:

- description of the response activity or job tasks to be performed;
- duration of the planned employee activity;
- site topography and accessibility by air and roads;
- identified safety and health hazards;
- hazardous substance dispersion pathways; and
- emergency response capabilities.

7.1 Training

All contractors will receive applicable training, as outlined in 29 Code of Federal Regulations (CFR) 1910.120(e) and as stated in the HASP. Site-specific training will be covered at the pre-entry briefing, with an initial Site tour and review of Site conditions and hazards. Records of pre-entry briefings will be maintained at the Site.

Elements covered in Site-specific training include:

- persons responsible for Site-safety;
- Site-specific safety and health hazards;
- use of PPE;
- work practices;
- engineering controls;
- major tasks; and
- decontamination procedures and emergency response.

Other required training, depending on the particular activity or level of involvement, includes OSHA 40-hour training and annual 8-hour refresher courses. Other training may include, but is not limited to, competent personnel training for excavations and confined space. Copies of Site personnel OSHA certificates will be maintained at the Site and in employee personnel records.

7.2 Personal Protective Equipment

Minimum PPE requirements while performing the sampling task or other field activities outlined in this GMP include:

- hard hat;
- safety glasses with side shields;
- steel-toe boots;
- high-visibility reflective vest;
- nitrile and/or leather work gloves (as needed); and
- long sleeve shirt.

Additional PPE may be required depending on the work task and may include but not limited to respirators, goggles, chemical protective suits, fall protection, or hearing protection.

The use of respiratory protection is not anticipated to be necessary for the field activities identified in this GMP but each situation will be evaluated individually based on equipment used (potential to create dust), location (potential to encounter impacted soils), and general field conditions. These items will be reviewed in a pre-start safety review that includes the Project Manager, field staff, and the Site Safety Officer. If sufficient potential exists, field personnel will be issued fit-tested respirators and monitoring will be conducted to determine actual dust or constituent concentrations in the air. Actual use of respirators will only be required if concentrations exceed OSHA permissible exposure limits (PEL). Further detail on the use and selection of respirators is provided in the HASP.

7.3 Work Risk Assessment

Work Risk Assessment (WRA) is a tool that is used to identify the hazards associated with all aspects of a specific task and to then identify the preventive actions that can be implemented to minimize the hazards. Control of the hazards can be accomplished by: 1) elimination of the task; 2) use of engineering controls to reduce exposure to the hazard; or 3) use of PPE to protect personnel from injury.

Comprehensive WRAs are completed for the field tasks required in this GMP before the work is initiated and are developed jointly by the field staff conducting the work and the Site Safety Officer. All field staff and sub-contractors review the WRAs before conducting the work and frequently throughout the task to identify new hazards or controls. Task-specific WRAs are kept on-Site at all times. A general summary of the potential hazards for groundwater sampling and related tasks is provided in Table 7-1. Task-specific WRAs for groundwater sampling of wells are provided in Appendix G, and are subject to revision at any time before or during implementation of these field activities.

Table 7-1. Work Risk Assessment Summary	
Field Activities	**Potential Hazards**
1. Monitor well installation	▪ Inhalation of silica sand, bentonite, or concrete dust. ▪ Lifting and ergonomic hazard from handling heavy bags of sand, bentonite, or concrete.
2. Monitor well development	▪ Skin irritation from dermal or eye contact with purged groundwater. ▪ Slipping or falling on uneven or wet ground surface. ▪ Overhead hazard with pump truck mast and bailer.
3. Piezometer installation	▪ Same as previous for monitor well drilling and installation
4. Groundwater (monitor well) sampling	▪ Skin irritation from dermal or eye contact with groundwater. ▪ Slipping or falling on uneven or wet ground surface ▪ Burn or corrosion from sample preservatives. ▪ Lifting and ergonomic hazards from lifting sample pump and sample cooler
5. Pumpback well system evaluation	▪ Same as previous for monitor well drilling and installation
6. General activities	▪ Heat stress due to high ambient temperature, improper clothing, lack of ventilation, lack of water, or lack of shade; or ▪ Hypothermia or frostbite due to low ambient temperature, improper clothing, damp or wet clothing, or lack of source for heat. ▪ Sunburn from lack of shade or improper clothing. ▪ Biological hazard from contact with spiders, insects, or reptiles.
7. Unsafe conditions	▪ Unexpected hazardous conditions such as wind, rain, snow, fire, earthquake, or other natural disaster can occur.

Note: This is a partial list of potential hazards. The proper WRA(s) should be reviewed before commencement of work activities.

SECTION 8.0

REFERENCES

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